

83 pages to the applied geomorphology of reclaimed land, slope stability, and urban hydrology and sedimentation.

John Pitts' contribution on the Quaternary of Singapore deserves special attention for its clear analysis of the Quaternary stratigraphy, discussion of changing sea level, and palaeohydrology. The Older Alluvium, widespread in Singapore and the Malay peninsula, is now known to be a braided stream deposit, developed under a seasonal climate with mean annual rainfall of 1800 to 1900 mm. This seasonal climate, over the whole western part of the Sunda Shelf, suggests that some of the sandy deposits covered with poor *kerangas* forest in Borneo might have been formed in the same periods of the Quaternary under similar, seasonally wet climates. The detailed work undertaken in Singapore is thus a basis for wider investigation into the Quaternary of the equatorial lowlands of SE Asia.

The Kallang Formation, made up of marine, fluvial, littoral, coral reef and estuarine sediments, straddles a range of Late Pleistocene and Holocene environmental conditions and sea levels. Investigation of this Formation has been fostered by foundation engineering needs in Singapore in the 1980s, and despite having no surface exposures, the marine member covers 25 per cent of Singapore Island. Lowering of groundwater tables in the marine clay of the Kallang Formation can lead to large surface settlements and damage to both multi-storey and single-storey buildings, as Broms and Wong explain. Civil engineering has also assisted the study of weathering profiles and slopes in Singapore, but despite the importance of deep regoliths, there is scant mention of problems associated with colluvium overlying weathered rock *in situ*. The subdued relief of Singapore may mean that few such problems occur, but slope instability sometimes arises in colluvial materials.

Pitts reviews the literature on slopes, coastal

geomorphology, and erosion processes. Periods of slope instability occur after sufficient quantities of rain prior to failure have raised the water content of near-surface slope materials. A one-day rainfall of sufficient magnitude then has to occur to trigger failure. The precise volumes of five- and one-day rainfall which lead to landslide events are not fully known. Failures which occur in fill slopes on construction sites are among the largest landslides in Singapore. One at Bukit Gombak involved the movement of 50 000 m³ of material and badly damaged several houses. The techniques for managing water to achieve stable fill slopes need constant attention, as the collapse of a block of flats in nearby Kuala Lumpur in December 1993 tragically demonstrated.

Gupta's chapter on floods and sedimentation provides the best indication of the geomorphic consequences of Singapore's expanding urbanization. The widening of the upper part of the main Bukit Timah Canal from a 16 m trapezoidal drain to a 20–26 m U-drain indicates the magnitude of works needed to cope with urban runoff. Singapore has had to divert waters from the Bukit Timah Canal under a hill into a different catchment to avoid increasing the flood risk in the city centre. Ausafur Rahman provides some valuable data on soil mechanical and hydrological properties, finding, as do many others in SE Asia, that hydraulic conductivities are high near the surface but decrease below 10 cm. Only 2 per cent of throughfall becomes overland flow or shallow underflow in dry months and about 8 per cent in wet months. Although much useful local information is to be found in this book, this review suggests that it is in some ways more valuable as a piece of applied geomorphology than as a complete urban environmental analysis of a particular city.

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ROUGH WATER MAN: ELWYN BLAKE'S COLORADO RIVER EXPEDITIONS by R. E. Westwood, University of Nevada Press, Reno, Nevada, 1992. No. of pages: xxi + 259. Price: £25.00. ISBN 0-87417-188-1.

Rough Water Man provides a unique chronicle of the surveys of the deep canyons of the Colorado River which took place between 1921 and 1923 under the auspices of the USGS. Based on original field notes, in particular the diaries of Elwyn Blake (a junior member of several expeditions) and written by his nephew, the book offers an essentially personal, and frequently very intense, perspective of the exploitation of the Colorado River waters. It is a book which works well at a variety of levels, detailing the various river expeditions,

evaluating their importance in the development of the Colorado basin, and discussing the environmental and other issues surrounding the use of the river today.

The majority of the book forms a rites of passage narrative, beginning with Elwyn working as a printer's apprentice, his application to join the surveys, and charting his subsequent rise from staffman and cook's assistant to his eventual position as fully fledged boatman (a true rough water man). Here, the book is at its best, capturing the majesty of the landscape, the power of the river and the wonder of those privileged enough to be passing through it. There are also some revealing insights into the personal dynamics of the survey party, with its rigid social and scientific hierarchy and the differing responses to the highly routinized (but often life-threatening) task of surveying the line.

The later sections of the book see a 70-year-old Elwyn

returning to the river, this time as a sightseer in a commercial tourist raft. The author develops a powerful and poignant analysis of the scope, costs and benefits of the development of the Colorado, which, in less than one man's lifetime, has become one of the most physically controlled and institutionally encompassed rivers in the world. It is sobering to realize, for example, that during the 19th century the Colorado was navigable from its mouth to beyond Yuma, yet, with the exception of 1983, for over 50 years no water has reached the Gulf of California at all! Again, it is almost frightening to

learn that from Powell's expedition in 1869 to 1949, only 100 people ran the Grand Canyon, whereas today the figure is 14 000 per year, even after strict regulation.

The book will be useful for those concerned with the history of environmental exploitation. For those who want a chance to share in that fascinating obsession which working with rivers can bring, it is essential and compelling reading.

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RIPARIAN LANDSCAPES by G. P. Malanson, Cambridge University Press, Cambridge, 1993. No. of pages: x + 296. Price: £35.00 (\$59.95). ISBN 0-521-38431-1.

This timely book is the latest in the well established *Cambridge Studies in Ecology* series. It attempts the difficult task of fusing together a diverse and fast-growing literature on ecological, geomorphological and hydrological processes in riparian areas. These various bodies of literature are interfaced through the landscape ecology paradigm which runs as a dominant (and sometimes overbearing) theme through the book.

Chapter 1 considers the principles of landscape ecology and applies them to riparian environments in order to provide a unifying conceptual framework for their study. In Chapter 2 a number of definitions are given, many of them aimed at giving the reader a better grasp of landscape ecology terminology, others at clarifying the nature of terrestrial-aquatic gradients and of ecological and geomorphological processes operating along them. The values of riparian environments (aesthetic, recreational, economic and environmental) are also considered. A review of riparian literature by ecoregion (seven main types are chosen) forms the bulk of Chapter 3. The important point is made that dominant processes in riparian areas vary according to geographical location,

as do the steepness of ecological gradients between riparian and surrounding areas. Chapter 4, entitled 'Internal Structure' is long and covers a wide range of topics contributing to our understanding of ecological and geomorphological characteristics of riparian areas. The emphasis here is very much on the spatial arrangements of biotic and abiotic elements. In Chapter 5, the movements of water, sediments and nutrients between these elements are discussed. The dynamics of riparian species is the main subject of Chapter 6, and includes consideration of genetic flows, dispersal mechanisms and invasions of exotic species. In the final chapter, simulation models and their role in the conservation and management of riparian landscapes are discussed.

Despite poorly reproduced photographs, this book is an excellent guide to the literature on riparian ecology, with good geographical coverage. It is a shame that the rather contrived language of landscape ecology is at times in danger of confusing rather than enlightening the reader. While landscape ecology can provide a perspective for integrating our knowledge of processes in a more spatially explicit way, it is, as remarked by the author, rather more useful as a concept than it is as a practical approach to working in real places.

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AN INTRODUCTION TO GLOBAL ENVIRONMENTAL ISSUES by K. T. Pickering and L. A. Owen, Routledge, London and New York, 1994. No. of pages: xxiii + 390. Price: £50 (hb), £15.99 (pb). ISBN 0-415-10227-8 (hb), 0-415-10228-6 (pb).

A great deal of effort, both presentational and financial, has gone into this handsome text book. It has literary

quotes, colour plates, fashionable boxes, summaries of key points, annotated guides to further reading, a lengthy glossary, issues for discussion, and copious line drawings. It is also broad in scope, aiming 'to explain the science behind the world's physical systems and processes, building on this factual base to explore the world's major environmental concerns including the effects on and of human activity'.

A large chunk of the text, not far off a third, deals with